Optimizing doping parameters of target to enhance direct-drive implosion

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To enhance direct-drive implosion performance while keeping the risk of hydrodynamic instability at a low level, we have designed a procedure to optimize the parameters of the target doped with mid- or high-*Z* material. In the procedure, a one-dimensional implosion process is simulated, while the effect of high-dimensional instability on its implosion performance is simultaneously evaluated. To find the optimal doping parameters, the procedure is performed in the framework of global optimization algorithm, where we have used the particle swarm optimization [1] in the current work. The opacity of mixture materials quickly obtained by using an interpolation method, shows a good agreement with the data of TOPS [2], a widely-used doping program developed in the Los Alamos National Laboratory. To test the procedure, optimization has been carried out for the CH ablator in the double cone ignition scheme [3] by doping with Si and Cl. Both one- and two-dimensional simulations show that doping with either Si or Cl can efficiently mitigate the Rayleigh-Taylor instability [4] during the acceleration phase and does not result in significant degradation of the peak areal density. The results from one- and two-dimensional simulations qualitatively match with each other, demonstrating the validity of our optimization procedure. This optimization process will be a valuable tool in assisting us in the design of the target and in furthering our understanding of direct-drive implosion physics.

References

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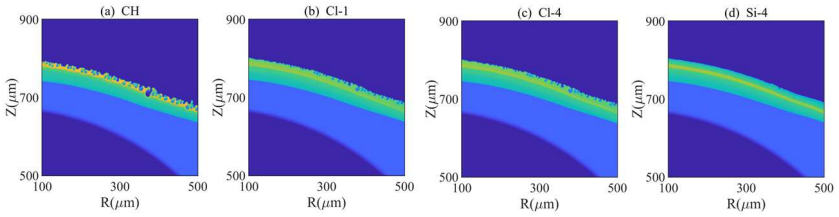

FIG. 1 Schematic diagram of the density of (a) undoped case CH, (b) single-layer optimizing doping case with Cl, (c) 4-layer doping case with Cl, and (d) case Si-4 at 7 ns.